

R	G	B
R	G	B
R	G	B

Fig. 1a

[illegible]

R	G	B
G	B	R
B	R	G

Fig. 1b

R	G
G	B

Fig. 1c

- Step 1: Calculate the low-pass filtered luminance of the image
(from the data of the pixel and its neighbor pixels)
- Step 2: Calculate the chrominance of each pixel
(only the chrominance channel which corresponds with the
color filter of the pixel)
- Step 3: Interpolate chrominances in each pixel with a 'vote'
operator
(use the chrominance data of a small set of pixels
around the pixel)
- Step 4: Calculate the high-resolution luminance data of each pixel
(from the chrominance and the sensor data of the pixel)
- Step 5: Calculate the full color (RGB) image
(from the luminance and the chrominance data)

Fig:2

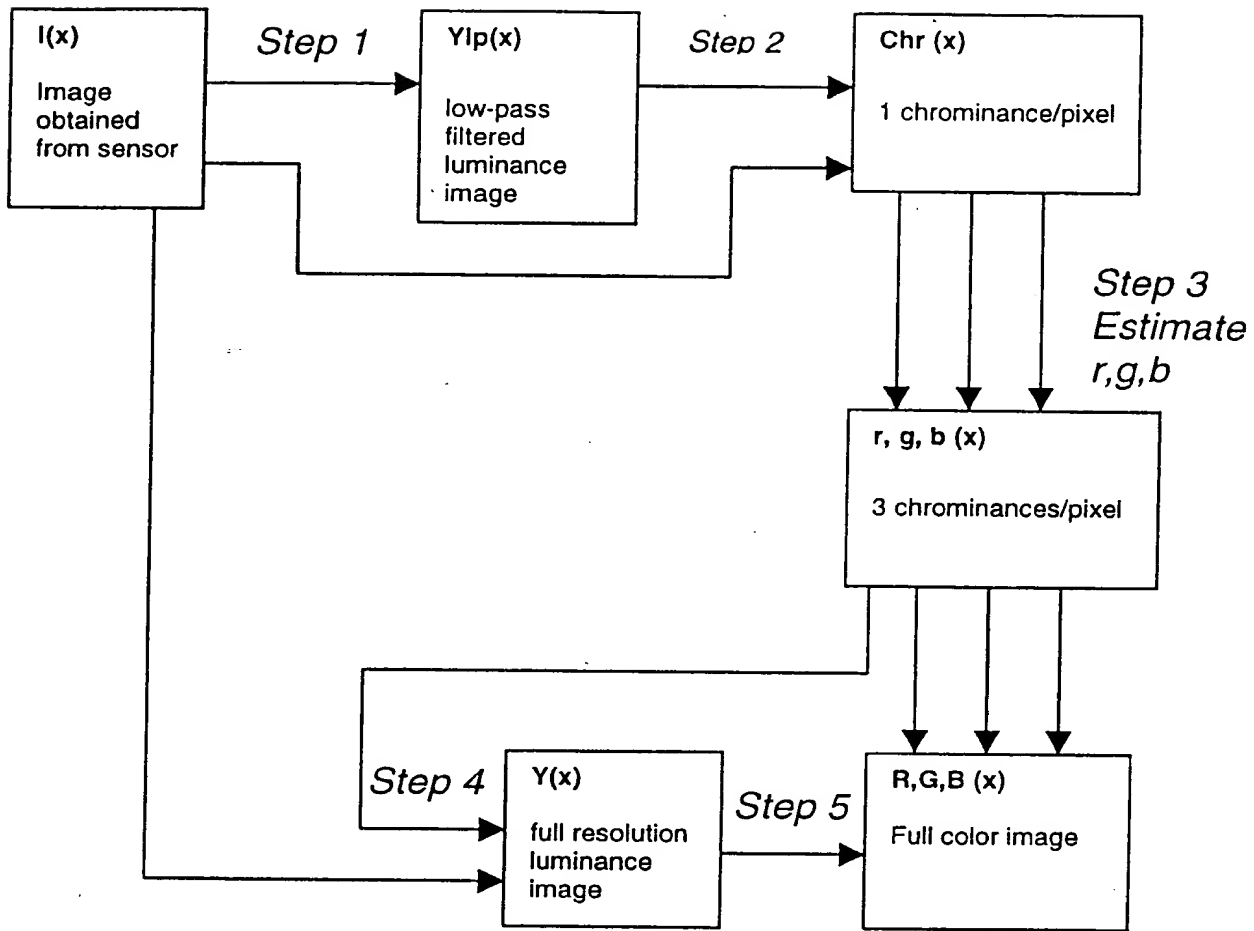


Fig. 3

Consider a window of 11 pixels around the pixel the colour of which is to be determined.

Step 1: For the 9 middle pixels of this window

$$\text{Calculate } Y_{lp}(x) = [I(x-1) + I(x) + I(x+1)]/3$$

$Y_{lp}(x)$ is the low-pass filtered luminance of the pixel at position x .

Step 2 : Calculate for the 9 middle pixels of this window:

For additive color processing

$$\text{Chr}(x) = I(x) - Y_{lp}(x)$$

For multiplicative color processing

$$\text{Chr}(x) = I(x)/Y_{lp}(x)$$

$\text{Chr}(x)$ is the estimated chrominance of the pixel at position x which corresponds with the color of the pixel at position x

3 red, 3 green and 3 blue chrominances are calculated $r_1, r_2, r_3, b_1, b_2, b_3, g_1, g_2, g_3$

Step 3 : Estimate from the 3 chrominances from a color channel the chrominances r, g, b of the pixel:

$$r = \text{vote}\{r_1, r_2, r_3\}$$

$$g = \text{vote}\{g_1, g_2, g_3\}$$

$$b = \text{vote}\{b_1, b_2, b_3\}$$

Step 4 : Calculate full-resolution luminance Y

For additive color processing

$$Y = I - \{r \text{ or } g \text{ or } b\}$$

For multiplicative color processing

$$Y = I/\{r \text{ or } g \text{ or } b\}$$

Y is the luminance of the pixel that is interpolated

I is the pixel intensity of this pixel, measured by the image sensor

$\{r \text{ or } g \text{ or } b\}$: the chrominance which corresponds with the color filter of the pixel is chosen

Step5 : For additive color processing

$$R = Y + r$$

$$G = Y + g$$

$$B = Y + b$$

For multiplicative processing

$$R = Y * r$$

$$G = Y * g$$

$$B = Y * b$$

Fig. 4

The green pixel G5 needs to be interpolated. The pixel array looks as follows:

B0 R1 G2 B3 R4 G5 B6 R7 G8 B9 R10

Step 1 : Calculate Ylp

Ylp1 = {B0 + R1 + G2}/3
Ylp4 = {B3 + R4 + G5}/3
Ylp7 = {B6 + R7 + G8}/3

Ylp2 = {R1 + G2 + B3}/3
Ylp5 = {R4 + G5 + B6}/3
Ylp8 = {R7 + G8 + B9}/3

Ylp3={G2 + B3 + R4}/3
Ylp6={G5 + B6 + R7}/3
Ylp9={G8 + B9 + R10}/3

Step 2 : calculate chrominance of each pixel

r1 = R1/Ylp1
r4 = R4/Ylp4
r7 = R7/Ylp7

g2 = G2/y1p2
g5 = G5/y1p5
g7 = G8/y1p8

b3 = B3 / Y1p3
b6 = B6 / Y1p6
b9 = B9 / Y1p9

Step 3 : chrominance interpolation

r=vote(r1,r2,r3)
g=vote(g1,g2,g3)
b=vote(b1,b2,b3)

Step 4 : calculate high-resolution luminance

Y=G5/g

Step 5 : calculate RGB data

Fig. 5

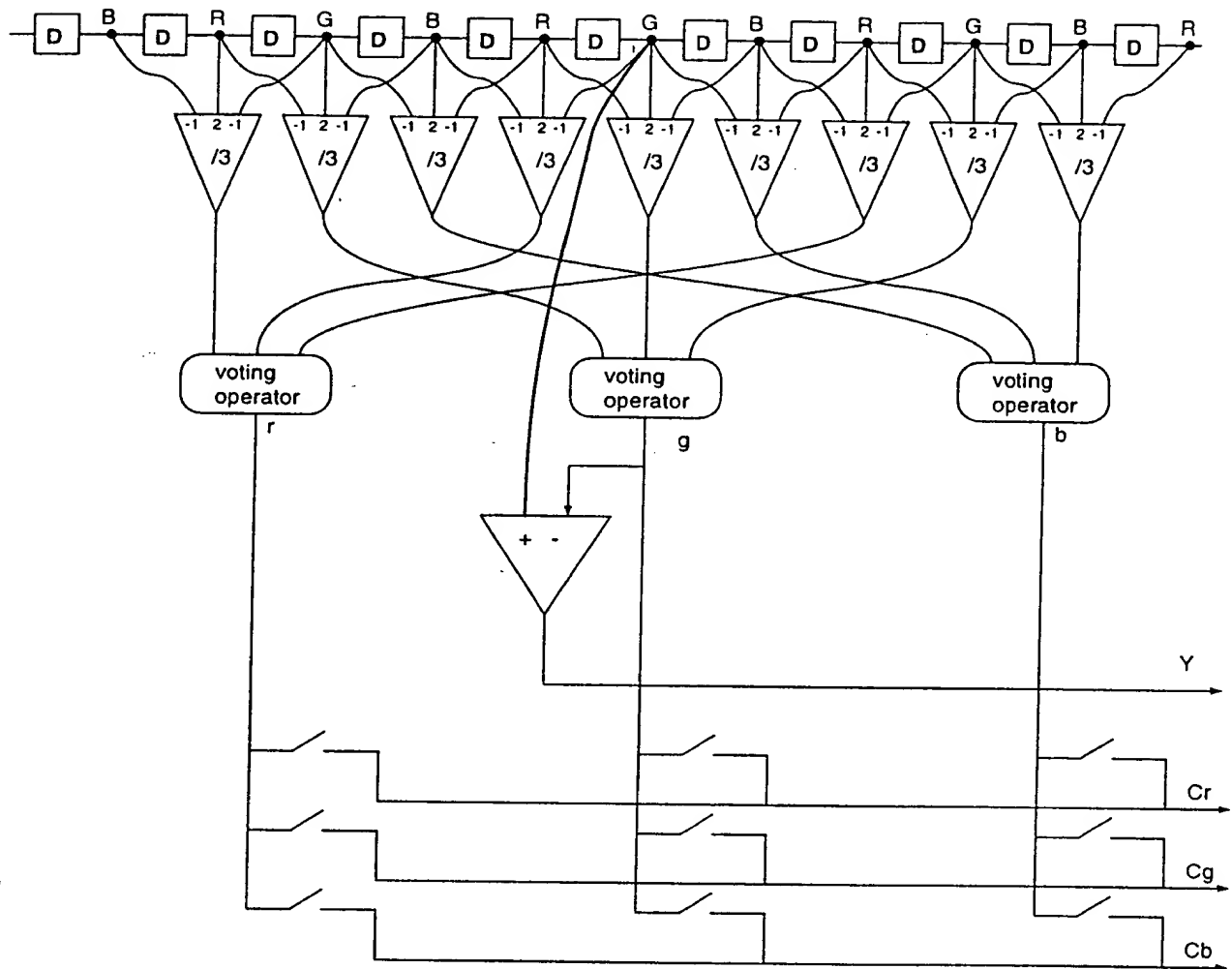


Fig. 6

Electrical specifications		
signal range	2-4 V	
Noise	< 1.3 mV	RMS variation on output
S/N ratio	64 dB	1670:1
Pixel frequency	typ. 8 MHz	
Output data delay	80 ns	after rising clock edge, 1 V swing, error < 10 mV
Rise time	84 ns	1 V swing, rising signal
Signal slew rate	12 V/ μ s	
Dissipation	100 mW	at 8 MHz including 3 output amplifiers
Dimensions		
PR 16 cell	1.7 x 1 mm ²	without pads
PR 16 IO	2.5 x 1.7 mm ²	includes bond pads
Package	28 pins DIL	
Process	0.7 μ m	analog/digital CMOS

Fig. 7

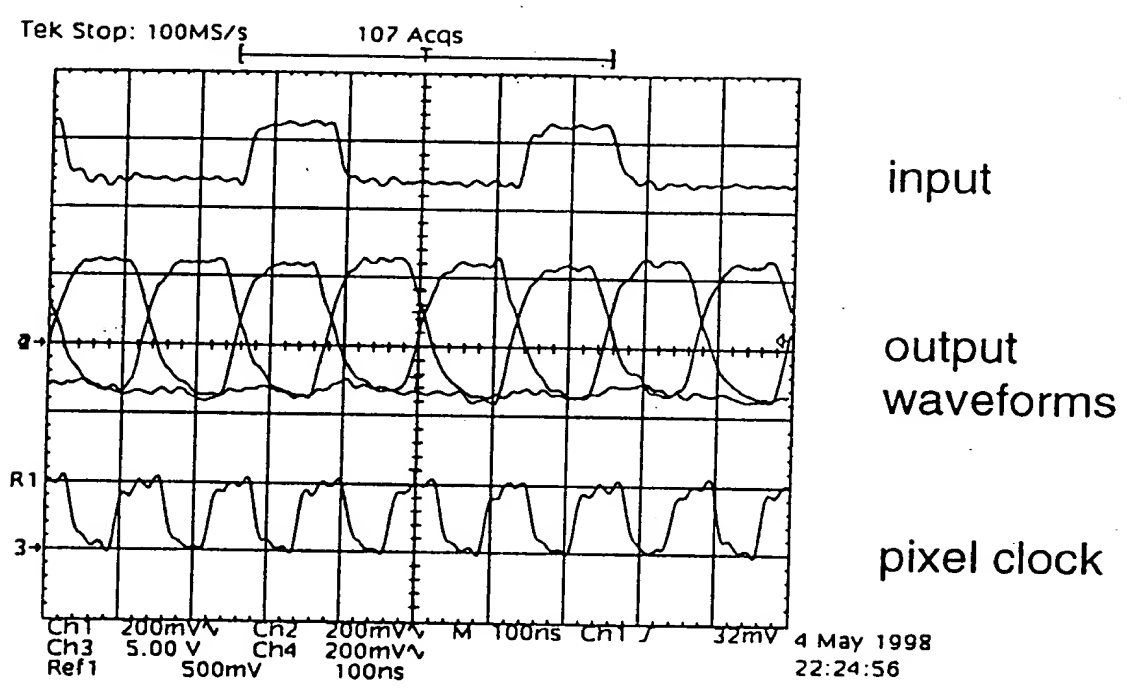


Fig. 8

66067-945160

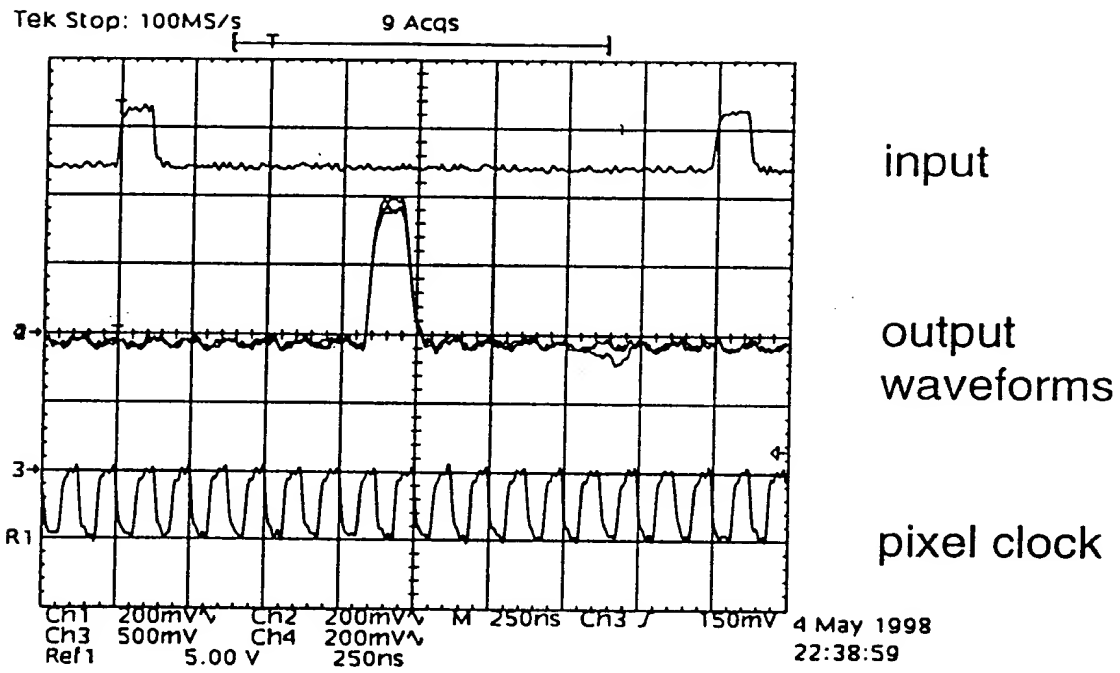


Fig. 9

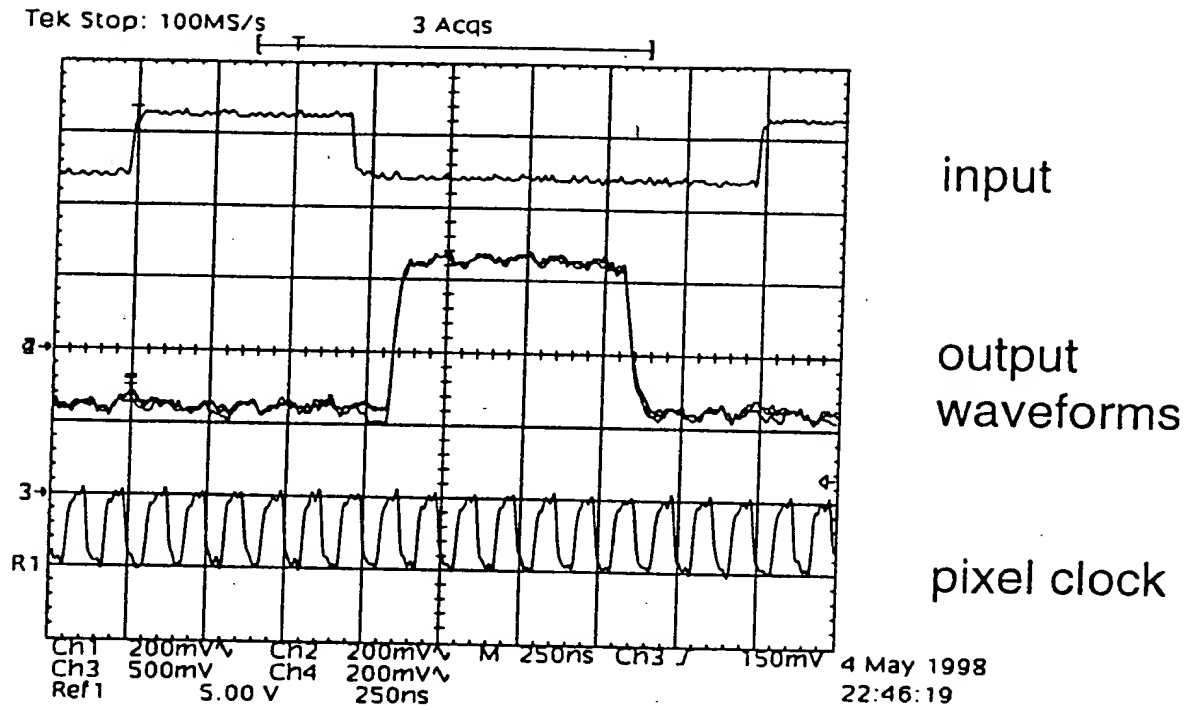


Fig. 10

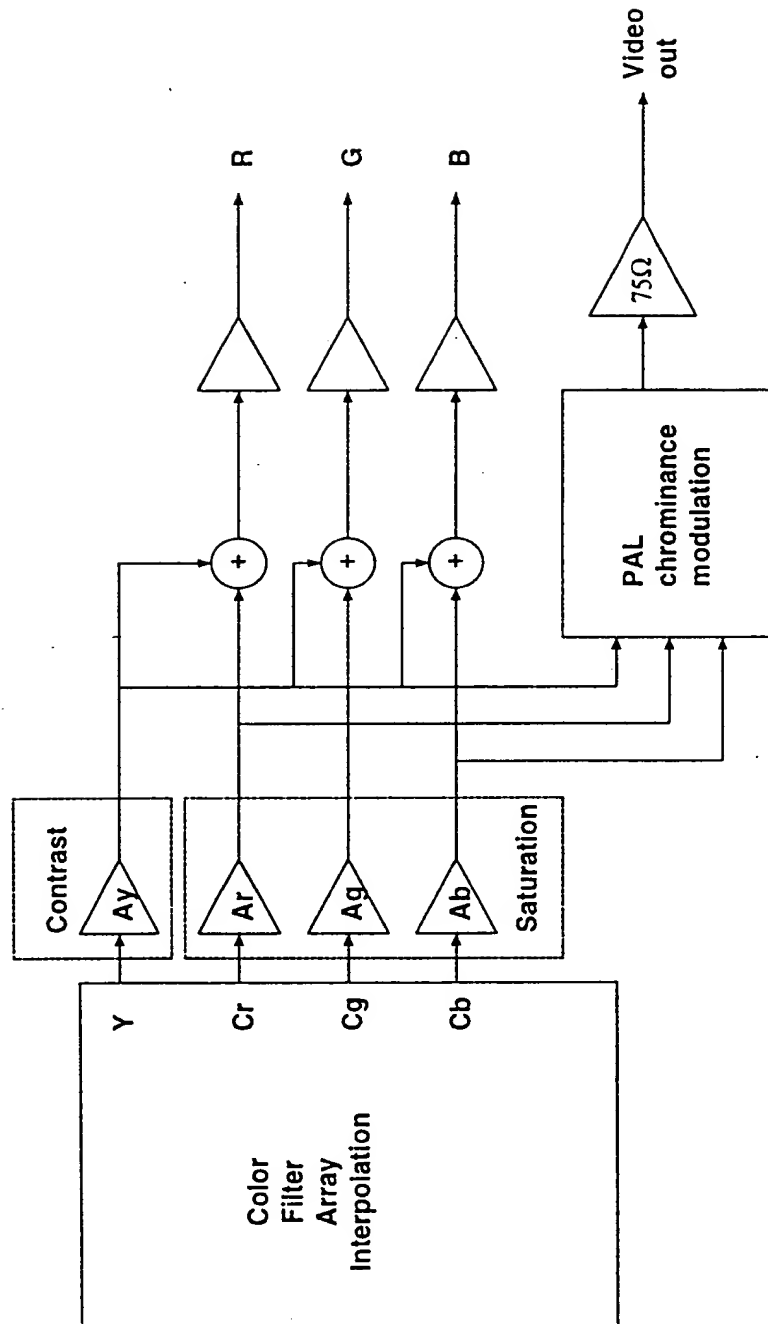


Fig. 11

B1	R2	G3
R4	G5	B6
G7	B8	R9

Method for interpolating pixel at position 5:

- 1) Calculate a low-pass filtered image:

$$Y2 = (B1 + R2 + G3) / 3$$

$$Y5 = (R4 + G5 + B6) / 3$$

$$Y8 = (G7 + B8 + R9) / 3$$

- 2) Calculate chrominance of each pixel

$$b1 = B1 - Y2 \quad r2 = R2 - Y2$$

$$r4 = R4 - Y5 \quad g5 = G5 - Y5$$

$$g7 = G7 - Y8 \quad b8 = B8 - Y8$$

$$g3 = G3 - Y2$$

$$b6 = B6 - Y5$$

$$r9 = R9 - Y8$$

- 3) Interpolation

$$r5^* = \text{median} \{r2, r4, r9\}$$

$$g5^* = \text{median} \{g3, g5, g7\}$$

$$b5^* = \text{median} \{b1, b6, b8\}$$

- 4) Luminance of pixel 5

$$Y5 = I5 - g5$$

- 5) RGB data of pixel 5

$$R5^* = Y5 + r5$$

$$G5^* = Y5 + g5$$

$$B5^* = Y5 + b5$$

Fig. 12